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CCE-32 1.01.3

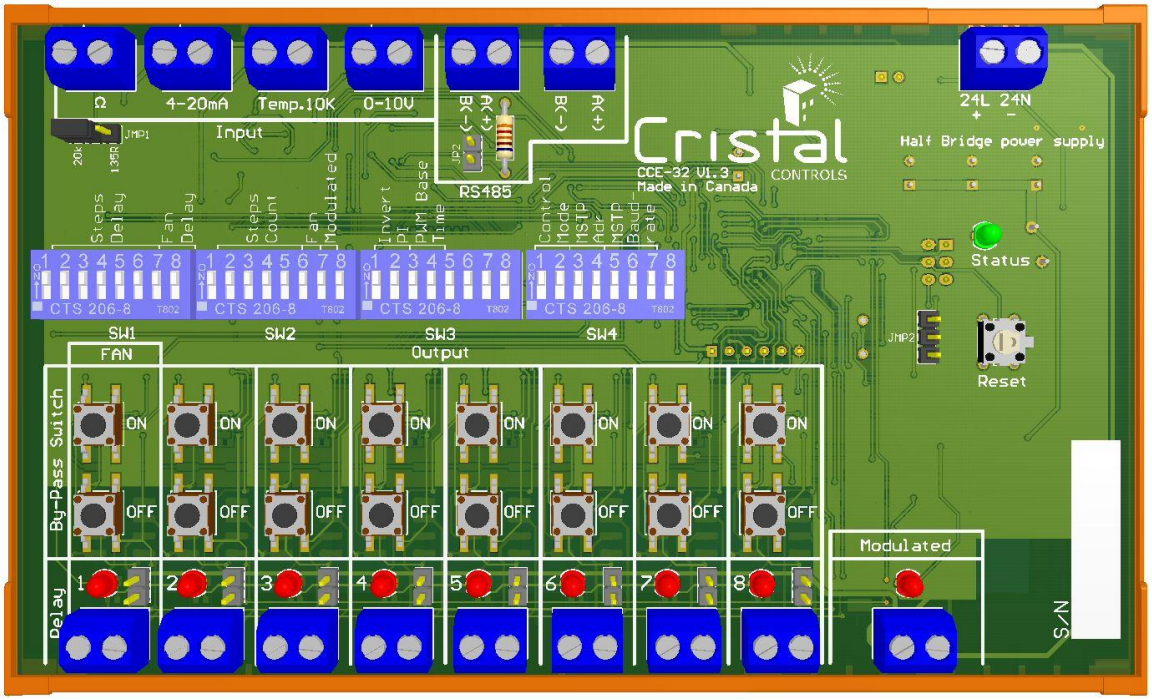

Image may differ from the actual product

2012-11-19

By Martin Labbé, eng.,

Jasmin Goupil & Louis Perreault

Cristal Contrôles Ltd
2025 Lavoisier, Local 135
Québec, (Québec) Canada G1N 4L6
Tél 418-681-9590 Fax 418-681-7393
http://www.cristalcontrols.com

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2025 Lavoisier, Local 135
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Charts List

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Tél 418-681-9590 Fax 418-681-7393
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1. General description

Cristal Control CCE-32 step controller is a basic 1 x Analog output + 8 ON-OFF steps controller. Up to 4 CCE-32 can be stack for a total of 1 x Analog output and 32 ON-OFF steps using the BACnet protocol between the 4 CCE-32. The first CCE 32 is a master the other 3 (slave) only offers ON-OFF relays outputs.

The CCE-32 offers 8 ON-OFF relay outputs with one which can be configured for a fan or circulating pump. The analog output can drive upon configuration either an SSR or a SCR. 3 inputs are available (0-10 VDC, 4-20 mA, resistive 0-20K Ohms or 0-135 Ohms).

2. Applications

The Cristal Control CCE-32 is design to control multiples outputs base on the inputs value. The following mode are supported FIFO (First In First Out, LIFO (Last In Last Out) or binary mode is also supported. In addition, a power integrator can be applied to the calculation steps. The CCE-32 offers manual control on all steps using the onboard buttons.

3. Installation

The Cristal Control CCE-32 uses a 35 mm (1.4'') Din-rail enclosure to facilitate the installation.

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4. Connections

All connections on the CCE-32 are screw type terminals.

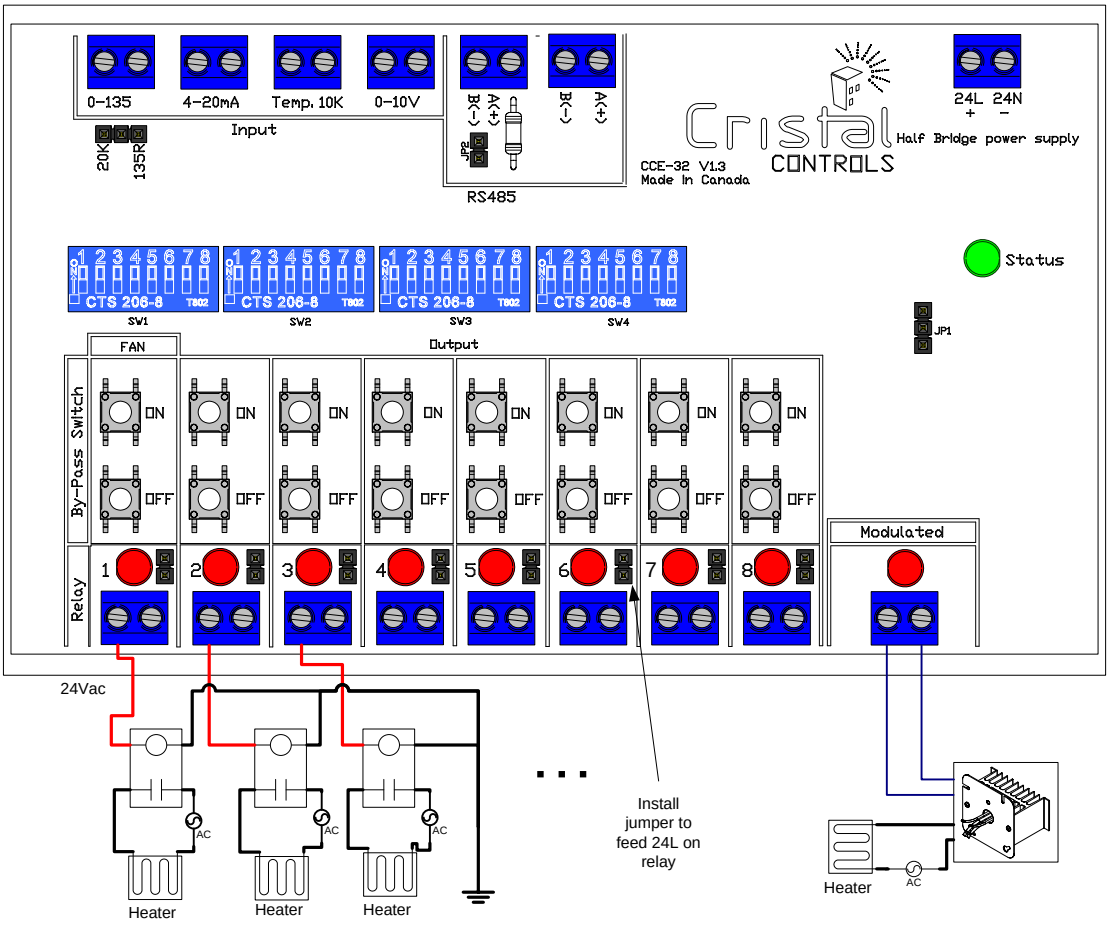

Figure 1 - Connections with jumper (24L from board)

⚠	**CAUTION: ELECTRICAL HASARD** It Is recommended to shut power off before proceeding to inputs and load connections.

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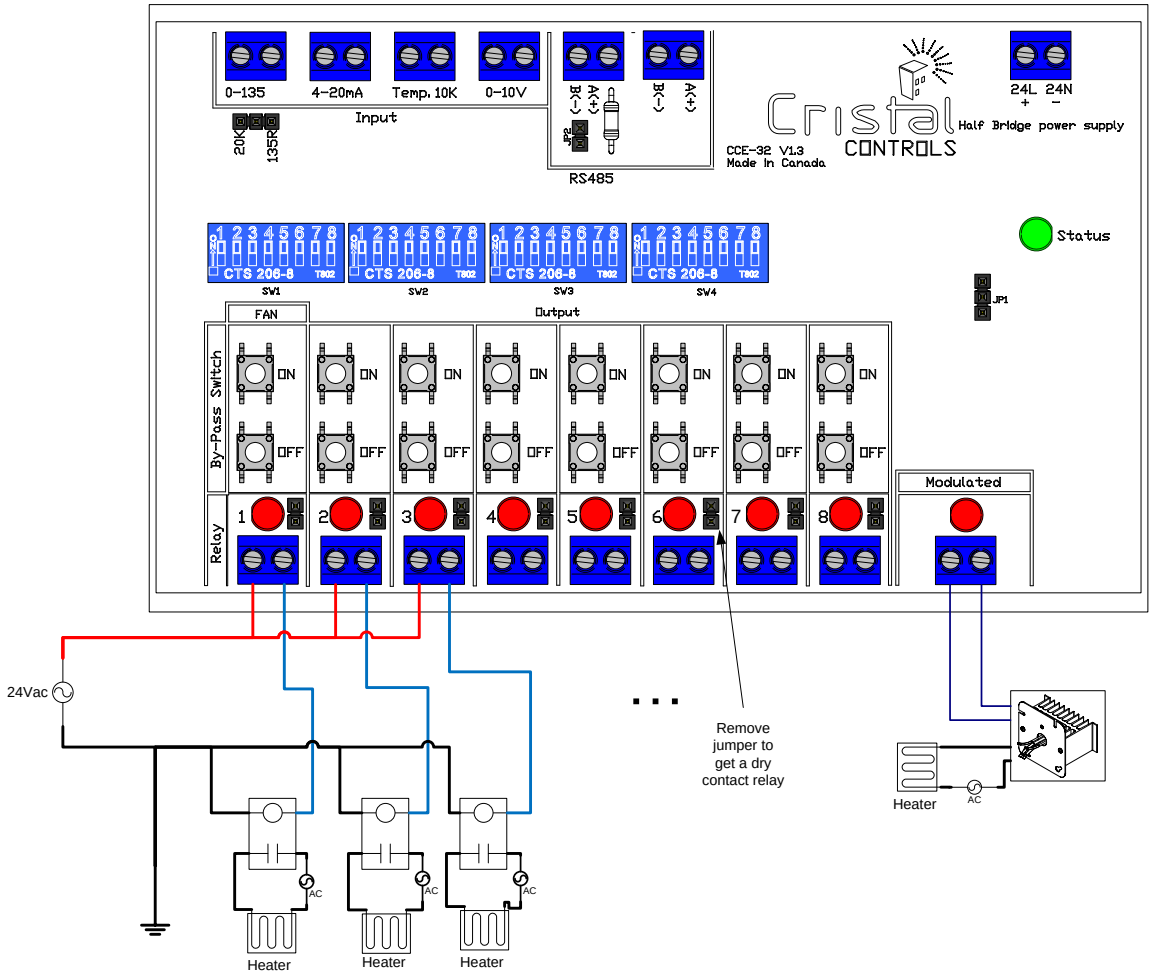

Figure 2 - Connections witout jumper (Dry contact)

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4.1. *Terminal description*

Output 1-8	On-Off contacts for steps.
FAN	Contact for fan or circulating pump.
Modulated	Analog Output.
Ω	0-20K Ohms or polarize 0-135 Ohms Input.
4-20mA	4-20 mA input.
Temp. 10k	Temperature sensor input (reserved).
0-10V	0-10 Volt input.
A(+)	RS-485 positive connection.
B(-)	RS-485 negative connection.
24L+	Positive power supply.
24N-	Negative power supply.

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5. Inputs

The CCE-32 controller has 3 inputs. The controller reads the input signal and converts it in a percentage to select the number of steps needed to be activated. A 2% hysteresis cycle is applied to the algorithm to avoid relay cycling.

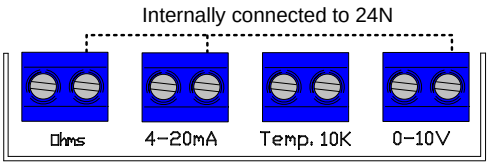

Figure 3 - Inputs

5.1. *0-10 VDC*

0-10 Vdc input, uninsulated with a 30K Ω impedance

5.2. *4-20 mA*

4-20mA input uninsulated.

5.3. *Resistive*

0-20K Ohms input or 0-135 Ohms uninsulated.

5.4. *Temperature*

The temperature input is reserved for advanced configurations when integrating with a BACnet building management server.

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6. CCE-32 Outputs

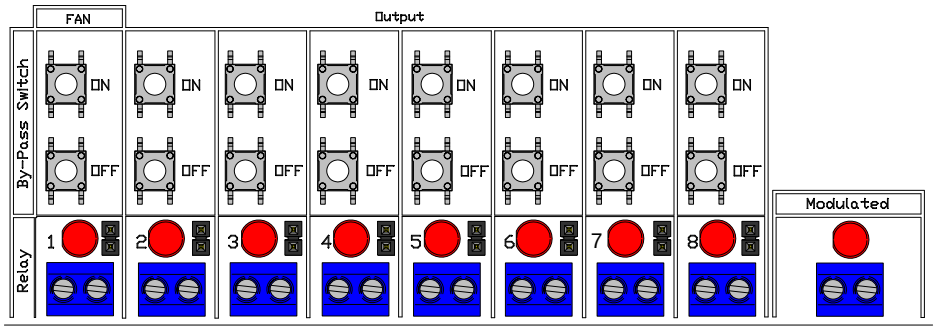

Figure 4 - Outputs

6.1. *8x Relays*

The CCE-32 outputs relays are latching type low power 24 Volts @ 1A. The 2 buttons above the relays allows manual override of the output. To avoid relay changes from the internal software, we must also enable the manual mode from the configuration dip switches. See « 7.9 Control Mode » to configure manual mode.

6.2. *Modulated*

The CCE-32 has a modulation output which can drive an SSR or a SCR. The selection is done using the configuration buttons. When using an SCR the voltage output range from 0 to 10 Volts. When using an SSR the voltage output is 0 or 10 Volts.

The analog output is protected against polarity inversion using a 140 mA auto reset fuse. To reset the auto fuse feature disconnect the 24 Vac power supply for 1 second.

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7. Configuration

The CCE-32 is manually configurable using 4 x 8 buttons switches. When more than one CCE-32 are connected together, the following settings shall be done from the Master CCE-32

Cristal Control offers an online configuration tool at: www.cristalcontrols.com under « Products/ step controller ». This configuration tool will easy guide you in the CCE-32 settings; you will see exact switch positions to reproduce on your step controller.

7.1. *Activation times*

The activation time between stages can be set using SW1 pos. 1 to 6. The configuration uses a binary mode with a 1 second delay. The activation time can also be set from 0-63 seconds using the following formula:

*Activation Delay = position 6 * (2^5) + position 5 * (2^4) + position 4 * (2^3) + position 1 * (2^0)*

Activation times examples:

SW Positions						
1	**2**	**3**	**4**	**5**	**6**	**Activation Times**
ON	OFF	ON	OFF	OFF	OFF	5 seconds
OFF	ON	OFF	ON	OFF	OFF	10 seconds
OFF	ON	ON	ON	ON	OFF	30 seconds
OFF	OFF	ON	ON	ON	ON	1 minute

Chart 1 – SW1 1-6

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7.2. *Number of steps*

On SW2 pos. 1 to 5 let you set the number of stages to be controlled, the setting use a binary mode. 1 to 32 steps are available using the following formula:

*Number of steps = (position 5 * (2^4) + position 4 * (2^3) + position 3 * (2^2) +… position 1 * (2^0)) +1*

Setting examples:

SW Positions					
1	**2**	**3**	**4**	**5**	**Steps number**
OFF	OFF	OFF	OFF	OFF	1
ON	ON	ON	OFF	OFF	8
ON	ON	ON	ON	ON	32

Chart 2 – SW2 1-5

7.3. *Fan or circulating pump*

SW2 pos. 6 allows the configuration of a relay for a fan or a circulating pump. When « ON » the fan / circulating pump relay is used. This relay is always the first one on the master controller. It is turned ON when one of the steps is activated and stays activated until the last step is turned off and activation time elapsed.

7.4. *Fan or circulating pump activation time*

SW1 pos. 7 and 8 configure the time the fan / circulating pump is maintained ON after every steps is turned OFF. Time settings are 10 seconds, 30 seconds, 2 minutes or 5 minutes.

SW2 Position	SW1 Positions		
6	**7**	**8**	**Delay**
ON	OFF	OFF	10 seconds
ON	ON	OFF	30 seconds
ON	OFF	ON	2 minutes
ON	ON	ON	5 minutes
OFF	X	X	Not used

Chart 3 – SW1 7-8

7.5. *Modulating step*

On SW2, pos. 7, sets the Modulating step mode. OFF: 0-10V mode is activated for the use with an SCR. ON: PWM mode is activated for the use with an SSR.

7.6. *PWM time base*

On SW3, pos. 3 and 4 are for the PWM time base, 4 pre set time are available.

Positions		
3	**4**	**Time base**
OFF	OFF	3 seconds
ON	OFF	1 minute
OFF	ON	5 minutes
ON	ON	10 minutes

Chart 4 – SW3 3-4

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7.7. *Inversion*

On SW3, pos. 1, ON invert the control signals. Example: a 0 volt input signal will enable 100% of the outputs and 10 volts input signal with disable every outputs (0%).

7.8. *Proportional Integral control (PI)*

On SW3 pos. 2, ON activate the PI Mode. For detailed explanation see section « 10.1 Proportional–Integral ».

7.9. *Control Mode*

On SW4, pos. 1 and 2 are for the control modes selection (4 available). The CCE-32 offers the following modes: FIFO, LIFO, BINARY and MANUAL.

SW Position		
1	**2**	**Mode**
OFF	OFF	Manual
ON	OFF	Fifo
OFF	ON	Lifo
ON	ON	Binary

Chart 5 – SW4 1-2

FIFO Mode

With this mode the first step to go ON will also be the first to go OFF

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As an example for a 4 steps system:

- An input signal rises to 50%; step 1 will go ON first and 2 next.

Relays →			
1	**2**	**3**	**4**
ON	**ON**	OFF	OFF

Chart 6 – Example FIFO 1

- When input signal falls to 0% then step 1 will go OFF and 2 next.

Relays →			
1	**2**	**3**	**4**
OFF	**OFF**	OFF	OFF

Chart 7 – Example FIFO 2

- Finally, when input signal increase again, the next step to go ON will be number 3.

Relays →			
1	**2**	**3**	**4**
OFF	OFF	**ON**	OFF

Chart 8 – Example FIFO 3

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LIFO Mode

On the LIFO mode the last step that goes ON Is the first to go OFF. So the first step to be ON is the last to be OFF.

Example on a 4 steps controller:

- With an input signal rising to 50%, step 1 will go ON and then step 2.

Relays →			
1	**2**	**3**	**4**
ON	**ON**	OFF	OFF

Chart 9 – Example LIFO 1

- With an input signal falling to 0%, the step 2 will go OFF and then step 1 next.

Relays ←			
1	**2**	**3**	**4**
OFF	**OFF**	OFF	OFF

Chart 10 – Example LIFO 2

- Then when the input signal rises, the next step to be ON will be the first one.

Relays →			
1	**2**	**3**	**4**
ON	OFF	OFF	OFF

Chart 11 – Example LIFO 3

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Binary Mode

With this mode all steps are binary controlled. The steps state is related to the activated steps. Binary mode is useful when each relay load is twice the capacity than the previous one.

Example :

Set to ON

Relays			
4 (800 Watts)	**3 (400 Watts)**	**2 (200 Watts)**	**1 (100 Watts)**
OFF	OFF	OFF	OFF
OFF	OFF	OFF	**ON**
OFF	OFF	**ON**	OFF
OFF	OFF	**ON**	**ON**
OFF	**ON**	OFF	OFF

Set to OFF

Chart 12 – Example Binary Mode

Manual mode

This mode disables software commands to the relays to allow manual operation of all steps using the on board buttons.

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7.10. *MSTP BACnet Network Address*

To allow the master controller communication of relay states to the slaves, we must configure an address and tie a network between the controllers.

On SW3, pos. 3 and 4 configure the MSTP network address.

Positions			
3	**4**	**Information**	**Relays**
OFF	OFF	Master	1-8
ON	OFF	Slave 1	9-16
OFF	ON	Slave 2	17-24
ON	ON	Slave 3	25-32

Chart 13 – SW4 3-4

When the controller is accessed from BACnet tools, the DIP switches affect BACnet properties « Device Name », « Device Identifier » and « MSTP MAC » address. The DIP switches configure controllers on a consecutive address range.

7.11. *MSTP BACnet Network speed*

The default network speed is 38400 baud. This speed can be changed for BACnet integration of the step controller with a building management server.

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On (SW4) switches 5, 6, 7 are used to change the default factory setting. The following chart shows the procedure.

Positions			
5	**6**	**7**	**Baudrate**
OFF	OFF	OFF	9600
ON	OFF	OFF	19200
OFF	ON	OFF	38400
ON	ON	OFF	57600
OFF	OFF	ON	76800
ON	OFF	ON	115200
OFF	ON	ON	230400
ON	ON	ON	38400 (Default setting)

Chart 14 – SW4 5-7

7.12. *BACnet Read Property Multiple*

On SW4 pos 8 identify if the BACnet service “Read Property Multiple” is used. At ON position the service is in use by the CCE-32. This function may be used when integrating the CCE-32 with a building management server and is generally enabled.

Note: The step controller is not using this feature for communication between the master and its slaves.

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7.13. *Resistive input*

The resistive control input is set using a jumper on (JPM1). The available settings are 20K Ohms (with the jumper on the left side) or 135 Ohms (with the jumper on the right side)

It is important to place the jumper on one of the 2 positions even when another type of control input is use.

8. Communication

The communication between CCE-32 master and slaves is based on BACnet MSTP protocol on a RS 485 network. This network is also use to control inputs values.

8.1. *Network characteristics*

When the CCE-32 controller is at one end of a RS-485 network, we must enable the 120-Ω terminating resistor by installing JP2 to end the network.

For more information, refer to the Cristal Controls manual “Setting up a RS-485 Network”.

Next is the BACnet objects list. This list is simple and many objects allow direct control on inputs and outputs of the controller. Communication with these objects allows integration of the CCE-32 controller with a building management server.

8.2. *Network Objects*

The CCE-32 has different type of Bacnet objects. (They are listed in the next chart)

Object	Description	Value	Value Type	Default Value	Object Type
IN 0-10V	Represents the input value 0-10 V	0-100%	Percentage	0	Analog Input
IN 4-20mA	Represents the input value 4-20 mA	0-100%	Percentage	0	Analog Input
IN OHMS	Represents the input value resistive	0-100%	Percentage	0	Analog Input
IN TEMPERATURE	Represents the input value in temperature	degree Celsius	degree Celsius	0	Analog Input
CURRENT-INPUT	Input value used by the control sequence	0-100%	Percentage	0	Analog Value
MODULATED	Value of the modulated output	0-100%	Percentage	Value determined by the controller	Analog Value
RELAY 1	Relay 1	ON or OFF	Boolean	State relay according to the controller	Binary Output
RELAY 2	Relay 2	ON or OFF	Boolean	State relay according to the controller	Binary Output
RELAY 3	Relay 3	ON or OFF	Boolean	State relay according to the controller	Binary Output
RELAY 4	Relay 4	ON or OFF	Boolean	State relay according to the controller	Binary Output

RELAY 5	Relay 5	ON or OFF	Boolean	State relay according to the controller	Binary Output
RELAY 6	Relay 6	ON or OFF	Boolean	State relay according to the controller	Binary Output
RELAY 7	Relay 7	ON or OFF	Boolean	State relay according to the controller	Binary Output
RELAY 8	Relay 8	ON or OFF	Boolean	State relay according to the controller	Binary Output
SET-POINT	Temperature setpoint	Degree C	Degree C	21	Analog Value
PERCENT PER DEGREE	Weight percentage of a degree Celsius.	0-100%	Percentage	10	Analog Value
SET-POINT-MIN	Minimum temperature set point	Degree C	Degree C	15	Analog Value
SET-POINT-MAX	Maximum temperature set point	Degree C	Degree C	25	Analog Value
FILE 0	Controller configuration steps	-	-	-	BACnet File
CCE-32	CCE-32 Information	-	-	-	Device

Chart 15 – BACnet Objects

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9. Status

A LED indicates the status of the CCE-32controller

Description		
Master	Slaves	Blinking rates
Shows normal working mode.	Shows normal working mode	1 Hz
Shows the master cannot communicate relay commands to its slaves.	Shows the slave did not received relay commands from its master CCE-32.	10 Hz

Chart 16 – Status

10. Software Algorithm

The CCE-32 controller does auto detection of the analog input in service. The input with the highest signal is selected the control algorithm. The number of steps is calculated in function of the percentage of the input signal.

If the fan / circulating pump output is enabled, this output goes ON at the same time than the first stage. This output stays ON while any step is active and turns OFF after all fixed and modulated steps are fully OFF and the configured delay elapsed.

10.1. *Proportional–Integral control*

The CCE-32 proportional–integral controller (PI controller) is a generic control loop feedback mechanism (controller) widely used in industrial control systems – a PI is the most commonly used feedback controller. A PID controller calculates an "error" value as the difference between a measured process variable and a desired setpoint. The controller attempts to minimize the error by adjusting the process control inputs

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11. Dimensions

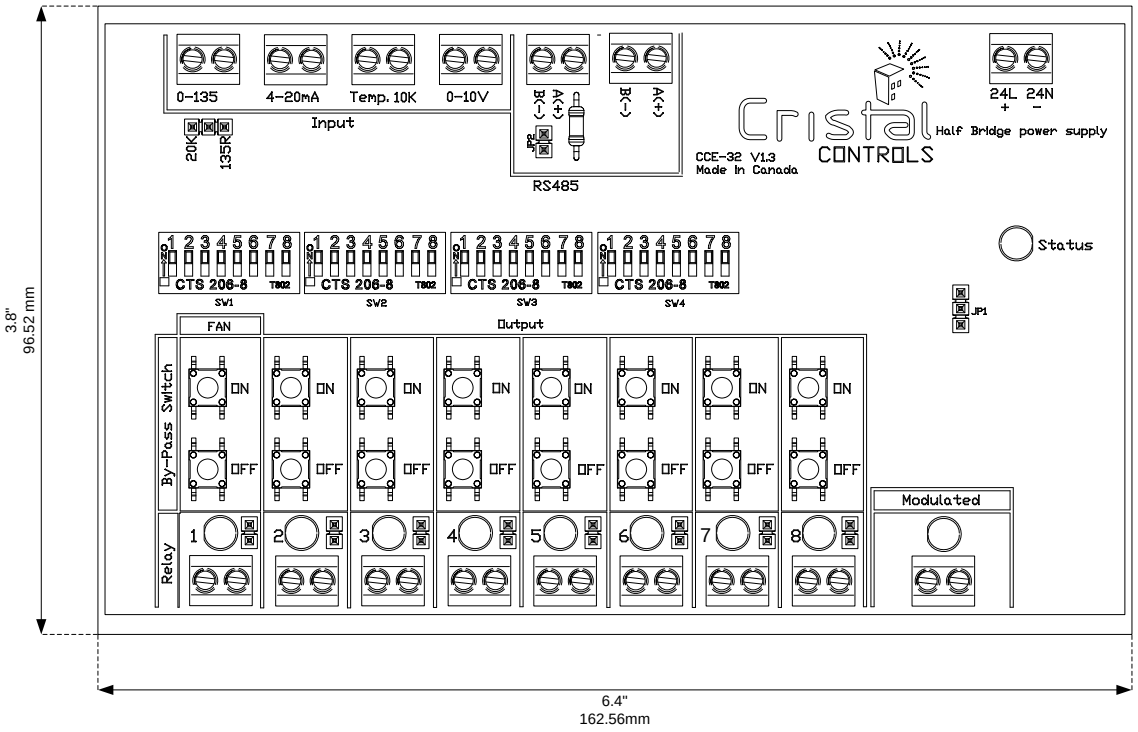

Figure 5 - CCE-32 Dimensions

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12. Hardware specifications

- Microcontroller : Freescale MCF51QE128
- Communication : RS-485 / BACnet MSTP.
- Supply Voltage : 18 – 28 Vac « Half Wave »
- Supply Current : 40 mA typical, 50 mA max
- Operating temperature : 10ºC à 45ºC (50ºF à 113ºF)
- Storage temperature : -30ºC à 80ºC (-22ºF à 176ºF)

12.1. *Outputs*

- 8x Dry Contact: 1A @ 24Vac / 30Vdc
- 1x Analog 0-10Vdc protected @ 5mA

12.2. *Inputs*

- 1x Analog 0-10 Vdc with a 30k Ω impedance
- 1x Resistive Analog, 0-20K Ω or 0-135 Ω
- 1x Analog 4-20 mA
- 1x Thermistor NTC 10 KΩ (10°C to 60°C)

12.3. *Jumpers*

- JMP1 : Resistive input type selection
- JP2 : Termination RS-485 of 120Ω.

12.4. *Switches*

- 4x Modules DIP of 8 positions each.

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13. Switches listing

	Position	Description
SWITC #1	1	Activation delay
	2	Activation delay
	3	Activation delay
	4	Activation delay
	5	Activation delay
	6	Activation delay
	7	Motor activation time
	8	Motor activation time
Switch #2	1	Stages numbers
	2	Stages numbers
	3	Stages numbers
	4	Stages numbers
	5	Stages numbers
	6	Motor Step
	7	Modulating step
	8	

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Switch #3	1	Inversion
	2	Proportional Integral Control
	3	PWB Base Time
	4	PWB Base Time
	5	
	6	
	7	
	8	
Switch #4	1	Control Mode
	2	Control Mode
	3	Bacnet MSTP Network address
	4	Bacnet MSTP Network address
	5	BACnet MSTP Network Speed
	6	BACnet MSTP Network Speed
	7	BACnet MSTP Network Speed
	8	BACnet Read Property Multiple

Chart 17 – Switches Listing

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